Tachi Laboratory (Special Issue on the Commemoration of the Fortieth Anniversary)

TACHI LABORATORY (January 1943～November 1962)

Head: Dr. Isamu Tachi

Dr. Isamu Tachi, Professor of Agricultural Chemistry in Kyoto University, was the Head of Tachi Laboratory in the Institute for Chemical Research from 1943 until his retirement in 1962.

Main subjects of his laboratory were researches in interfacial electrical phenomena and coagulation of colloid particles. Scientific papers published before 1951 were reviewed in the Commemoration Volume for the Silver Jubilee of the Institute. A brief review of the works published since that time will be given in the following.

I. Interfacial Electrical Phenomena

The mechanical vibration of the electrical double layer gives rise to the generation of an alternating voltage of the same characteristics as the orginal vibration (U-effect). In the case of glass-liquid interfaces this effect can be used to measure the streaming potential by an a-c technique. For mercury-solution interfaces, an alternating current is generated, which provides new methods for double layer capacity measurements, e.g. the impedance matching method. These phenomena could also be used in various practical applications as mechano-electric tranducers, e.g. the pick up of an electrophonograph, hydrophone etc. Differential capacities of the electrical double layer at mercury-solution interfaces were measured by the resonance and a-c bridge methods as well. The free energy of adsoprtion and the adsorption kinetics of nonionic surface active agents from solutions were discussed on the basis of the experimental results thus obtained. The effect of the electrical field in the double layer on adsorption behaviours of inorganic anions as well as that of organic materials, especially of dioxane, was also studied.

II. The Mechanism of Coagulation

The stability of hydrophobic colloids is mainly governed by the magnitude of the potential energy of repulsion due to the superposition of electrical double layers and van der Waals attraction between approaching particles. In the absence of potential barriers, every collision between particles leads to adhesion (rapid coagulation), and in the presence of potential barriers, the probability of collision is decreased, thus leading to slow coagulation. A quantitative theory was given by Reerink and Overbeek to describe the influence of the double layer thickness at constant Stern potential on colloid stability, a situation which occurs when indifferent inorganic electrolytes are added to sols. While, Ottewill, Rastogi and Watanabe gave a theory which treated the case where the change in the Stern potential occurs due to adsorption. An extended theory of coagulation was also given which treated the general case of changing ionic strength and potential.

The experimental verification of the theory thus obtained was carried out by measuring the coagulation kinetics of positively charged silver iodide sols spectrophotometrically. Electrokinetic measurements were also made by using ultramicroelectrophoresis. The agreement between the theory and experiments was very good and a reasonable value of the van der Waals constant was obtained.

Publications

(* indicates an article published in Japanese)

I. Interfacial Electrical Phenomena

1. S. Ueda, A. Watanabe and F. Tsuji: Studies on the Surface Electrical Phenomena, *J. electrochem. Soc., Japan (Denki Kagaku)*, **19,** 142, 193 (1951); **20,** 605 (1952); **21,** 14, 267, 390 (1953); **22,** 179, 521, (1954); **24,** 74, 116 (1956); **29,** 634, 701, 777 (1961); **30,** 576, 582, 657 (1962); **31,** 32 (1963).*
2. S. Ueda, A. Watanabe and F. Tsuji; Studies on Surface Electricity, *Mem. Coll. Agr., Kyoto Univ.*, **60,** 1, 8, 13 (1951); **67,** 61, 69, 73, 79 (1954).
3. S. Ueda, A. Watanabe and F. Tsuji; Studies on Surface Electricity, *Bull. Inst. Chem. Res., Kyoto Univ.*, **24,** 12, 30 (1951); **28,** 47; **29,** 32; **30,** 15 (1952); **31,** 1;2, 178, 249 (1953); **32,** 54, 62 (1954); **33,** 91 (1955); **34,** 1, 65 (1956); **38,** 59 (1960); **42,** 10 (1964).
4. A. Watanabe, F. Tsuji and S. Ueda; Studies on the Electrical Double Layer, *Kolloid-Z.*, **191,** 147; **193,** 39 (1963); **198,** 987 (1964).
5. A. Watanabe, F. Tsuji and S. Ueda; Theory and Application of U-effect, *Proc. 2nd Intern. Congr. Surface Activity,* III, 3, 96 (1956).
6. A. Watanabe; A-C Methods in Interfacial Electrical Phenomena, *J. Electrochem. Soc.*, **110,** 72 (1963).
7. S. Ueda, and A. Watanabe; On U-effects (Review), *Chemistry and Industry (C.S.J.)*, **4,** 4 (1951),
8. A. Watanabe and S. Ueda; Recent Developments of the Studies on the Theory of Interfacial Electrical Phenomena, *J. electrochem. Soc., Japan (Denki Kagaku)* **20,** 247, 308, 358, 419 (1952).*
9. S. Ueda and A. Watanabe; Measurements of Interfacial Phenomena, *Experimental Chemistry* **7,** 343 (1956), Maruzen Book Co., Tokyo.*

II. The Mechanism of Coagulation

1. A. Watanabe; Physico-chemical Studies on Surface Active Agents, *Bull. Inst. Chem. Res., Kyoto Univ.*, **38,** 158, 179, 216, 265, 248, 274 (1960).
2. R.H. Ottewill and A. Watanabe; Studies on the Mechanism of Coagulation, *Kolloid-Z.*, **170,** 38, 132; **171,** 33; **173,** 7, 122 (1960).
3. R.H. Otteoill M.C. Rastogi and A. Watanabe; Studies on the Mechanism of Coagulation, *Trans. Faraday Soc.*, **56,** 854 (1960).
4. R. Horne, R.H. Ottewill and A. Watanabe; Studies on the Preparation of Metallic Salts of Tetradecyl Sulfate, *Proc. 3rd Intern. Congr. Surface Activity,* I, 203 (1961).